Habitat selection of the Broad-tailed Gecko *Phyllurus platurus* in an urban Sydney bushland remnant

Matthew Mo

College of Health and Science, University of Western Sydney, Locked Bag 1797, South Penrith Distribution Centre, Australia 1797.

Current address: NSW Department of Primary Industries, PO Box 242, Parramatta NSW 2151, Australia.

Email address: matthew.mo@dpi.nsw.gov.au

ABSTRACT

The Broad-tailed Gecko *Phyllurus platurus* is a saxicolous lizard occurring in the Sydney Basin including the Sydney Metropolitan Area. A search of desktop records confirms that populations remain across the region, including in the central business district and in long-established suburbs. This paper reports on habitat selection derived from a population study carried out in a reserve of remnant bushland in the St George district. Open walls and the underside of overhangs were the most frequently exploited structures used by *P. platurus*. Geckos were found typically no higher than 2.5 m from the ground. The mean density of *P. platurus* had a negative relationship with available rock surface area. Geckos retaining original tails dominated the sample size, which is in contrast to previous work on museum specimens. Diurnal surveying was trialled, during which some *P. platurus* were detected on the outer edges of crevices. Survey results expand baseline information and inform future decisions aimed at promoting biodiversity in remnant bushland.

Key words: Habitat fragmentation, remnant bushland, saxicolous lizard, Sydney Metropolitan Area, urban ecology

DOI: http://dx.doi.org/10.7882/AZ.2014.002

Introduction

The Broad-tailed Gecko *Phyllurus platurus* is a nocturnal saxicolous lizard found in the Sydney Basin and surrounds (Wilson and Swan 2013). It is the most southerly-occurring leaf-tailed gecko (genera *Phyllurus* and *Saltuarius*), being easily distinguishable from other lizards within its distribution by its tail (Figure 1). Another key feature is the flattened, speckled body covered with small raised prickles. Despite inhabiting remnant bushland and some urban environments of the Sydney Metropolitan Area (Shea 2010), published literature on the ecology of *P. platurus* is scarce.

The earliest work focusing solely on *P. platurus* was by Green (1973), who reported observations of the reproductive strategy. Mating occurs in autumn and sperm is stored over winter for immediate fertilisation in early spring, essentially giving juveniles sufficient time to accrue food reserves prior to their first winter. Aspects of reproduction were investigated further by Doughty and Shine (1995), in what is perhaps the most comprehensive work carried out on *P. platurus*. Their paper describes a highly seasonal reproductive cycle, with females producing two clutches of two eggs per year. Crevices with sand substrate are selected for nesting, which may house up to 24 eggs and be used by the same breeding individuals in subsequent seasons (Swan and Ehmann 1996).

Populations of *P. platurus* occur in a variety of forest types, though prominently those concentrated around rocky outcrops (Swan et al. 2004). Their habitat selection should be considered to be broad, given that other members of the genus are restricted mainly to rainforest and wet sclerophyll forest (Wilson and Swan 2013). They will also take up residence in human dwellings close to suitable habitat (Shea 2010), and inhabit tree trunks where rock outcrops are sparse (e.g. in the Watagan Mountains; pers. obs). *Phyllurus platurus* show a preference for crevices that are spacious, but with tight-fitting openings and of even width (Stow 1998). Factors such as crevice orientation and moisture content are not influential (Stow 1998).

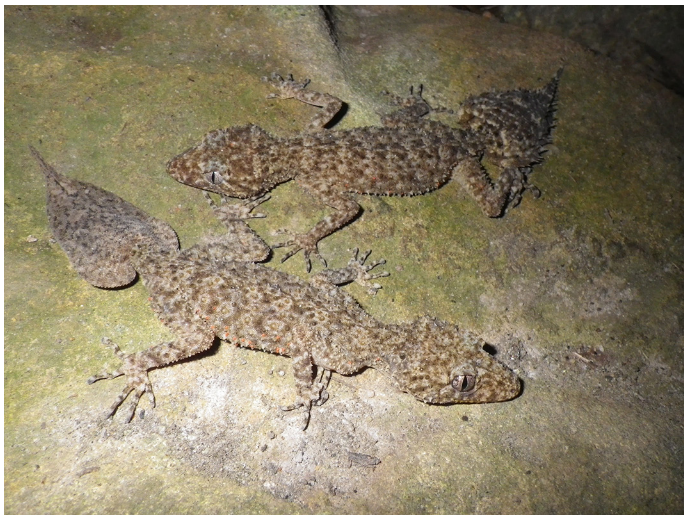

Figure 1. Broad-tailed Geckos *Phyllurus platurus* in the Lime Kiln Bay Bushland Sanctuary, Oatley. The tail of the lizard in the background has spiny tubercles, indicating that it is an original tail. In contrast, the lizard in the foreground has a smooth-textured tail, which is easily recognised as one that has regenerated after the original has been dropped.

This paper presents information on microhabitat selection in a reserve of remnant bushland in the St George district of Sydney. To complement the population study, sighting records of *P. platurus* within the Sydney Metropolitan Area were pooled to geographically show their distribution. The baseline ecological data collected in this study furthers our understanding and management of this species.

Methods

Records from the Sydney Metropolitan Area

I collated records of *P. platurus* from within the Sydney Metropolitan Area for the last 50 years (i.e. post 1962). This area is defined as the region east of the Blue Mountains, delimited by the lower Hawkesbury, Hills Shire, Hornsby and Pittwater local government areas (LGA) to the north, and the Liverpool, Campbelltown and Sutherland LGAs to the south. Records were sought from published manuscripts, reports and the Atlas of Living Australia (ALA 2012) and the Atlas of NSW Wildlife (OEH 2012) databases, which include museum records. I also included personal communications with seven correspondents, and my personal observations.

Population study

The population study focused on geckos in the Lime Kiln Bay Bushland Sanctuary (33°58' S, 151°03' E), located in the suburb of Oatley. The northern section of the bushland remnant contains a series of sandstone outcrops, which span about three hectares. The main canopy species are Sydney Red Gum Angophora costata, Red Bloodwood Corymbia gummifera and Sydney Peppermint Eucalyptus piperita. Eleven large sandstone formations occur longitudinally along a walking track and these were used as survey sites within the current work. Their proximity to each other is shown in Figure 2.

To calculate mean densities of geckos, I quantified the rock surface area at each site that was searched for geckos (Table 1). Many of the formations consisted of bare rock on one side and were covered in by elevated soil on the other side, such that surveying was restricted to the section of the site on the lower part of the slope (Figure 3B). A 60-m measuring tape was run on the ground along the rock surface that was surveyed for geckos, with the distance recorded as the 'site length'. For sites that were stand-alone from rising elevation (Figure 3A), the perimeter was measured to obtain the site length. For each site, heights were measured by suspending a measuring tape at 2-m intervals along the site length, with the values averaged to estimate a mean height. The rock surface area was then calculated by multiplying the site length with mean height. The structural features were also recorded to capture the structural complexity of each site.

Between March and May 2010, spotlighting surveys were carried out on 11 nights, during which the rock surface areas and crevices of each site were scanned systematically with a spotlight (Pianka and Pianka 1976). All sites were surveyed on each survey night. Ambient temperatures ranged from 16 to 26°C across all survey nights. The typical time period needed to search each site for geckos

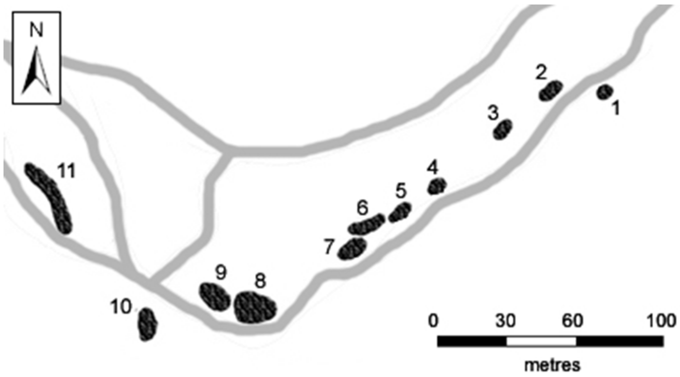

Figure 2. Map of the rocky section of the Lime Kiln Bay Bushland Sanctuary, Oatley. Sites are shown in proximity to each other. The walking tracks through this reserve are shown by the grey lines.

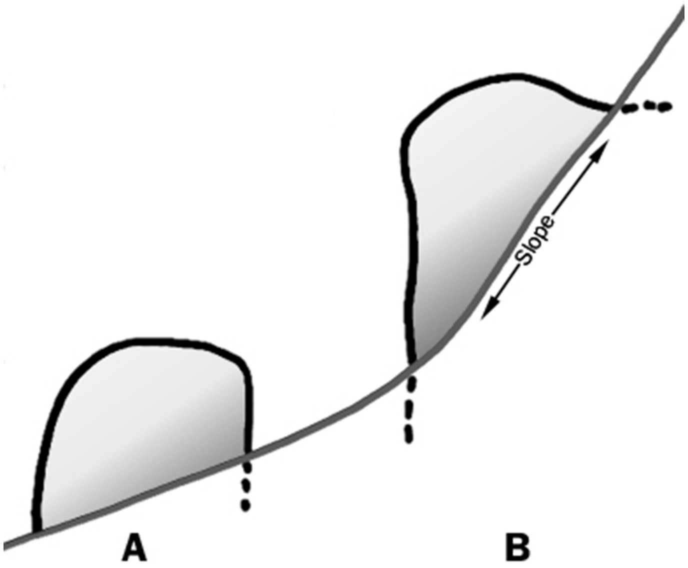

Figure 3. Cross-slope diagrammatic representations of stand-alone formations where rock surface is present around the entire perimeter (A) and formations that are covered in by elevated soil on one side (B).

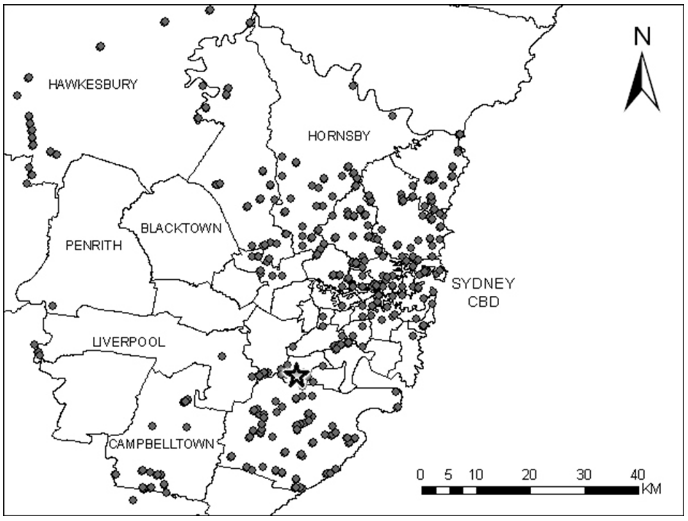

Figure 4. Spatial records of *P. platurus* in the Sydney Metropolitan Area between 1962-2012. Selected local government areas are labeled. The location of the Lime Kiln Bay Bushland Sanctuary is indicated by the star symbol.

Table 1. Summary of survey sites

C = Crevice. OW = Open wall. SW = Sheltered wall. O = Overhang. HS = Horizontal surface.

Site	Site length(m)	Mean height(m)	Estimated rock surface area (m^2)	Structural features present
1	10.4	2.3	24.3	C, OW, O, HS
2	10.1	1.5	15.2	C, OW, O, HS
3	5.6	1.1	6.0	C, OW, SW, O, HS
4	9.9	2.0	19.3	C, OW, SW, O, HS
5	10.5	2.8	29.4	C, OW, SW, O, HS
6	10.3	3.7	38.5	C, OW, O, HS
7	6.7	4.3	28.8	C, OW, SW, O, HS
8	19.3	6.5	125.1	C, OW, SW, O, HS
9	13.5	4.2	57.1	C, OW, O, HS
10	5.3	2.2	11.7	C, OW, O, HS
11	53.6	5.0	267.8	C, OW, SW, O, HS

was about five minutes, such that a complete survey typically lasted one hour.

Upon sighting, most geckos remained motionless and did not attempt to escape until they were hand-caught for examination. Snout-vent length (SVL) was measured to the nearest 0.5 cm by placing the specimen flat along a wooden 30-cm ruler. Sex was determined by observing the hemipenes. Tail form was recorded as original, regenerating or fully regenerated. An original tail has spiny tubercles, which fully regenerated tails lack (Doughty and Shine 1995). A tail in the process of regenerating has a purplish colouration and lacks obvious scalation.

For each gecko sighting, height above ground level was recorded and the structural feature it was perched on was scored as being a crevice, open wall, sheltered wall, underside of an overhang or a horizontal surface. A sheltered wall was defined as a vertical rock surface positioned opposite to another surface within a distance of 10 cm.

Data analysis

Analyses were based on the captures as a whole, hence including resightings. Mean gecko density for each site was calculated using count data per repeat survey and the estimate of surveyed rock surface area. Juvenile-adult ratios were determined for sites with sufficient sightings ($\geq$5 sightings over the course of the study) and the study area as a whole. I considered any specimen less than 70 mm SVL, the approximate length at sexual maturity (Doughty and Shine 1995), as a juvenile. Ratios for sex and tail form were also determined. Regression analysis was used to test the relationship between available dwelling height and the actual dwelling heights in which the specimens were found. The frequency of specimens observed on the five structural features identified was examined for the study area as a whole.

Diurnal surveying trials

Deep crevices are a notable retreat site for *P. platurus*. However, previous observations of geckos in more exposed positions during the day prompted me to conduct diurnal surveys in the same sites as described above. These previous observations include specimens on the outer edges of crevices and on the underside of overhangs during the day. Three surveys were conducted in the same systematic fashion as with nocturnal surveys at four-day intervals in June 2010. For definition purposes, any crevice space that could be visually examined without artificial lighting was considered the outer edge of a crevice. Geckos detected in these diurnal surveys were not captured for morphological measurements.

Results

Records from the Sydney Metropolitan Area

There were 232 records of *P. platurus* in the Sydney Metropolitan Area since 1962 (Figure 4), sourced mainly from databases (86%). An additional 32 locations were added from literature, personal communications and my own observations, listed in Table 2. Much of these data were recorded opportunistically, thus Figure 4 is not a comprehensive examination, but merely an indicative representation of distribution. This explains why sightings in the upper Hornsby LGA were not more extensive despite large tracts of rock escarpment. While many records originate from extensive bushland reserves, e.g. Ku-ring-gai Chase, Garigal and Royal National Parks, the data show a wide distribution across developed areas, including the Hurstville LGA where my population study was carried out. Notably, populations persist around the Sydney central business district (CBD) (e.g. Forest Lodge, Balmain and Vaucluse) and long-established suburbs in the North Shore, Inner West, Eastern Suburbs and Manly peninsula. There is an apparent absence across much of the western Cumberland Plain, i.e. the lower Hawkesbury, Penrith, Blacktown, Liverpool and Fairfield LGA's, which can be explained by a lack of suitable habitat.

Population characteristics

There were 97 gecko sightings recorded across the spotlighting season, ranging from 2 to 28 specimens found per survey night. There is likely to be a high proportion of resightings within the dataset. Two specimens with distinctive abnormalities were captured more than once

Table 2. Locations of *P. platurus* sightings from the Sydney Metropolitan Area, reported in literature, by personal communications and the author's personal observations.

Location	Year of sighting	Source
Balmain East	2012	D. Andrew, pers. comm.
Hornsby Heights	2012	Author's pers. obs
Manly	2012	Author's pers. obs
Narrabeen	2012	B. Law, pers. comm.
Watsons Bay	2012	Author's pers. obs
Dee Why	2011	N. Hunter, pers. comm.
Grays Point	2011	M. Winder, pers. comm.
Jannali	2011	Author's pers. obs
Kentlyn	2011	Author's pers. obs
Forest Lodge	2010	Shea 2010
Georges River National Park	2010	Cogger 2010
Kurnell	2010	Cogger 2010; DECCW 2011
Menai	2010	Hall and Hunter 2012
Oatley	2010	White 2010; B. Grover and J. Cockayne, pers. comm
Peakhurst Heights	2010	Author's pers. obs
Tamarama	2010	Semeniuk et al. 2010
Wolli Valley	2010	Little et al. 2010
Earlwood	2009	Author's pers. obs
Mortdale	2009	Author's pers. obs
Baulkham Hills	2008	Author's pers. obs
Allambie Heights	2006	Eco Logical Australia 2006
Lane Cove National Park	2004	NSW NPWS 1998; DEC 2004; Wilson and Swan 2013
Cammeray	2003	North Sydney Council 2003a,b
Dural	1999	Scanlon and Davidson 1999
Vaucluse	1999	B. Law, pers. comm.
Hornsby	1998	Stow 1998
Neutral Bay	1995	Shea 2010
Palm Beach	1992	Smith and Smith 1992
Turramurra	1992	Cogger 1992
Bellevue Hill	1990	Shea 2010; N. Hunter, pers. comm.
Beacon Hill	1989	Shea 2010
Normanhurst	1982	M. Nagel, pers. comm.
Parramatta	1969	Shea 2010

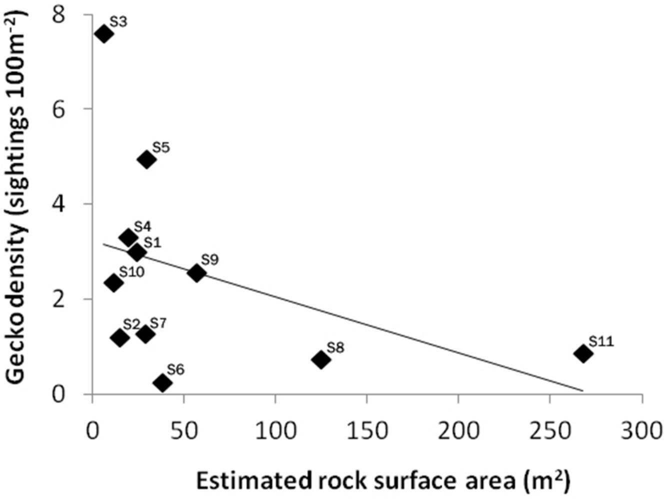

Figure 5. Variation in mean density of *P. platurus* between sites, and a negative relationship with estimated rock surface area. The data presented here are from spotlighting surveys only.

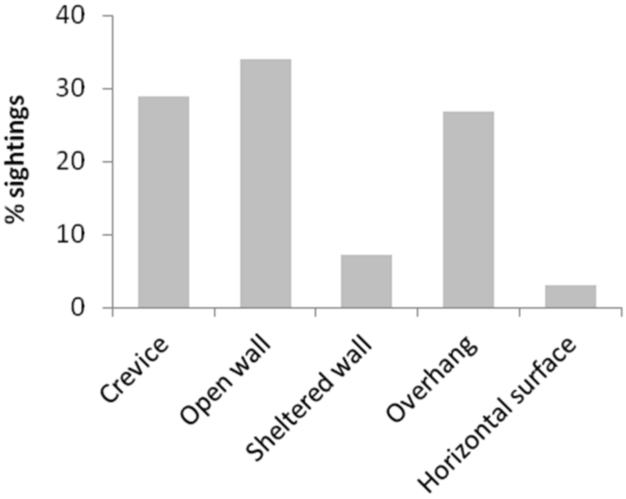

Figure 6. Frequencies of nocturnal dwelling on five structural features (n = 67).

(discussed later). In the absence of individual marking procedures (e.g. Bustard 1969), these were the only specimens that can be confidently identified as animals represented multiple times in the dataset. Substantial variation in mean density was observed between sites, which did not appear to be influenced by rock surface area available (Figure 5). Mean densities of *P. platurus* exceeded three animals per 100 m^2 in a third of the sites (Table 3).

Six sites (1, 4, 5, 8, 9 and 11) yielded substantial data for generating population proportion ratios based on various morphological characteristics (>0.5 geckos per survey night). Juveniles were far outnumbered by adults in all these sites, never representing more than 20% of the sample size (Table 3). Although inaccessible animals were grouped separately as 'unrecorded' (18% of total sample size), they were presumably all adults, based on observation. Sex ratios were relatively even in most sites. When data for the six sites were averaged, the overall sex ratio was found to be male-biased, with 1.3 males per female.

There was some variation in the ratios of tail forms between sites (Table 3). Overall, the original tail form was most

Table 3. Data collected from spotlighting surveys, including the total number of gecko sightings recorded in each site over the entire study period. Mean density of geckos for each site is presented as the number of geckos detected per 100 square metres (standard errors shown in parentheses). Density was calculated by dividing the mean number of geckos per survey night by the estimated rock surface area of each site (presented in Table 1). For the six sites that yielded substantial gecko numbers (sites 1, 4, 5, 8, 9 and 11), the percentage of juveniles in the total sample size, male-female (M/F) ratio and the percentages of three tail forms (OT = Original tail, FRT = Fully regenerated tail, RT = Regenerating tail) are presented.

Site	No. Sightings	Density	% juv.	M/F ratio	% OT	% FRT	% RT
1	8	3.0 (1.3)	0.0	2.0	50.0	25.0	12.5
2	2	1.2 (1.2)	-	-	-	-	-
3	5	7.6 (3.5)	-	-	-	-	-
4	7	3.3 (1.6)	14.3	1.0	42.9	57.1	0.0
5	16	4.9 (1.1)	18.8	0.7	25.0	31.3	43.8
6	1	0.2 (0.2)	-	-	-	-	-
7	4	1.3 (0.7)	-	-	-	-	-
8	10	0.7 (0.2)	0.0	1.0	60.0	40.0	0.0
9	16	2.5 (1.3)	6.3	0.6	50.0	25.0	12.5
10	3	2.3 (1.2)	-	-	-	-	-
11	25	0.8 (0.2)	4.0	2.8	64.0	32.0	4.0

commonly represented (≥50% in most sites), followed by the fully regenerated form (≤32% in most sites). At some sites, the original form dominated accounts of tail autonomy by up to 177%. Progressing tail regeneration was recorded rarely (mean of 6 sites = 11%).

Habitat use

Dwelling height available showed no relationship with the actual dwelling heights of *P. platurus* ($R^2 = 0.008$; $F_{1,96} = 0.76$, $p = 0.38$). Although the mean dwelling height available in sites, such as sites 8 and 11, were over 5 m, few individuals were observed more than 2.5 m from the ground. The highest perched *P. platurus* was recorded 273 cm from the ground on an open wall, at site 8. Individuals located in crevices represented 29% of nocturnal sightings (Figure 6). The most common structural features used during foraging were open walls (34%) and the underside of overhangs (27%). Dwelling on sheltered walls was rare (7%), although the scarcity of this structural feature should be noted. The use of horizontal surfaces was also uncommon (3%).

Debilitations in two adult male *P. platurus* allowed for positive identification upon recapture. An individual with an injury to the right eye captured at site 4 was located 15 days later. Another individual from site 11 carried an abdominal bulge and was located twice after eight and 47 days. In the case of both animals, recaptures occurred within 1 m from their initial capture positions.

Diurnal surveys resulted in 29 sightings, including possible recaptures, which consistently occurred at six sites (sites 1, 5, 7, 8, 9 and 11). The specimens recorded were all located on the outer edges of crevices, some exposed to direct sunlight when detected. This behaviour was most commonly observed in site 9 (>40% of all diurnal records).

Discussion

Phyllurus platurus remains widespread across much of the Sydney Metropolitan Area, including near the Sydney CBD. Their success is probably aided by the conservation of sandstone outcrops in remnant bushland and their capacity to take advantage of human dwellings (Shea 2010). There are no data available currently to indicate whether long-term persistence in built environments is possible without nearby remnant bushland. In other parts of Australia, gecko taxa have established in urban areas devoid of native bushland, e.g. the invasive Asian House Gecko *Hemidactylus frenatus* (Newberry and Jones 2007). Regardless, the ready use of artificial habitat would appear to be advantageous for *P. platurus* in the event of the fragmentation of natural habitat.

In this study, *P. platurus* preferred dwelling at lower heights, which may be a function of prey distribution along the height gradient. Cockroaches, crickets and moths dominate their diet (Green 1973), and the former two appear to be prominent at the base of rock outcrops (pers. obs). There was a disproportionately high number of *P. platurus* found on open walls and overhang surfaces, which are presumably the most suitable dwelling sites. Their actual reliance on such structural complexity remains to be confirmed by further work.

Historically, herpetofauna diversity has declined in response to habitat loss and fragmentation. Bush rock removal is particularly a concern for many saxicolous species (Schlesinger and Shine 1994; Hamer and McDonnell 2010), however the implications for *P. platurus* may not be as detrimental given that this species is rarely found under rocks (Stow 1998; pers. obs). This species does not have the typical characteristics that make a reptile species vulnerable to decline in an urban environment, i.e. large and conspicuous, regarded with 'pet appeal', broad dispersing, hazardous to human safety, and susceptible to invasive species (White and Burgin 2004). Instead, many aspects of its biology are advantageous:

- rapid maturation compared to other lizard taxa (Doughty and Shine 1995)
- a diet that includes arthropod orders that are abundant

in suburbia, e.g. Coleoptera, Orthoptera, Lepidoptera and Araneae (Green 1973; Threlfall et al. 2012)

- communal nesting, alleviating the pressure of limited nesting sites (Swan and Ehmann 1996)

This study is the first to quantify the localised abundance of *P. platurus*. Anecdotal observations suggest that they occurred in relatively high densities in sandstone habitat in the St George district in the 1960's (C. Lloyd, pers. comm.). The population study found that density varies significantly between sites in the Lime Kiln Bay Bushland Sanctuary, and rock surface availability was not necessarily a contributing factor.

Animals with the original tail form dominated the population studied. This differs from the ratio in museum specimens that have a much higher proportion (>60%) of animals showing past regeneration (Doughty and Shine 1995). Specific identification of predator taxa is not found in published literature, although tail autonomy also results from intraspecific conflicts (Green 1973). Given that fauna diversity in urban environments is generally reduced (Faeth et al. 2011), predator pressure on *P. platurus* is possibly alleviated in remnant bushland. In addition, species that live on vertical rock faces are unlikely to be targeted to any great extent by invasive carnivores such as foxes and cats. There may be a relationship between the high proportion of *P. platurus* with the original tail form and the high proportion of adult specimens. Animals living under low predation pressure would be expected to suffer fewer injuries and have increased longevity, hence reducing the urgency of recruitment. This hypothesis remains to be investigated.

This study represents a further development in baseline information of a species that is common, though largely unstudied. Studies on habitat selection in remnant bushland provide a valuable tool for informing decisions that aim to promote biodiversity in the urban landscape. The uniqueness of *P. platurus* among Sydney's herpetofauna makes it a geographically important species.

Acknowledgements

Data presented in this paper were collected as part of my Bachelor of Animal Science. I thank Anthony Leondis, Rob Jeges, Adrian Sciacca, Tammy Mo, Jon Fletcher, Sam Cox and Michael Parsons for assisting me in the field, and Traecey Brassil and Matt Nagel for their help with GIS software. Gecko sightings were contributed by Debbie Andrew, Jason Cockayne, Bill Grover, Nikki Hunter, Dr Brad Law, Matt Nagel and Mark Winder. The Oatley Flora and Fauna Conservation Society and the Lime Kiln Bay bushcare officers and volunteers have maintained an ongoing interest in this study. I particularly recognise the encouragement from the late George Rapley who we sadly miss. Useful comments by Dr Brad Law, Nikki Hunter, Dr Martin Predavec and two anonymous referees improved the manuscript. Field procedures were approved by the University of Western Sydney Animal Care and Ethics Committee and licensed by the New South Wales National Parks and Wildlife Service. Rob Casey of Hurstville City Council granted permission for the use of the study area.

References

Abramsky, Z. and Tracy, C.R. 1980. Relation between home range size and regulation of population size in *Microtus ochrogaster. Oikos* **34**: 347-355. http://dx.doi.org/10.2307/3544294

Atlas of Living Australia (ALA). Database available at http://www.ala.org.au. Accessed 1 November 2012.

Bustard, R.H. 1969. The population ecology of the gekkonid lizard Gehyra variegata (Dumeril and Bibron) in exploited forests in northern New South Wales. *Journal of Animal Ecology* **38**: 35-51. http://dx.doi.org/10.2307/2739

Cogger, H.G. 1992. Reptiles and Amphibians of Australia. Reed Books Australia, Melbourne.

Cogger, H.G. 2010. Sydney's herpetofauna: some observations on its history of discovery, biogeographic significance and contribution to the debate on effective reserve size. Pp. 198-218 in *The Natural History of Sydney*, edited by D. Lunney, P. Hutchings and D. Hochuli. Royal Zoological Society of New South Wales, Mosman NSW. http://dx.doi.org/10.7882/FS.2010.016

Department of Environment and Conservation. 2004. *Systematic Survey of Vertebrate Fauna in Lane Cove National Park.* Department of Environment and Conservation, Hurstville NSW.

Department of Environment, Climate Change and Water. 2011. *The Vertebrate Fauna of Kamay Botany Bay National Park.* Department of Environment, Climate Change and Water, Hurstville NSW.

Doughty, P. and Shine, R. 1995. Life in two dimensions: natural history of the Southern leaf-tailed gecko, *Phyllurus platurus*. *Herpetologica* **51**: 193-201.

Eco Logical Australia. 2006. *Manly Warringah War Memorial Park Fire Regime Management Plan.* Report prepared for Warringah Council. Eco Logical Australia Pty Ltd, Sutherland NSW.

Faeth, S.H., Bang, C. and Saari, S. 2011. Urban biodiversity: patterns and mechanisms. *Annals of the New York Academy of Sciences* **1223**: 69-81. http://dx.doi.org/10.1111/j.1749-6632.2010.05925.x

Green, D. 1973. Observations on the Southern leaf-tailed gecko *Phyllurus platurus* (Shaw). *Herpetofauna* **6**: 21-24.

Hall, C. and Hunter, G. 2012. *Still Creek Wetland Management Plan.* Report prepared for Sutherland Shire Council, and Sydney Metropolitan Catchment Management Authority. Molino Stewart Pty Ltd, and J. Wyndham Prince, Sydney.

Hamer, A.J. and McDonnell, M.J. 2010. The response of herpetofauna to urbanization: inferring patterns of persistence from wildlife databases. *Austral Ecology* **35**: 568-580. http://dx.doi.org/10.1111/j.1442-9993.2009.02068.x

Little, D., Stevens, P., Gatenby, G. and O'Brien, V. 2010. Fauna of the Wolli Valley in inner south-west Sydney. Pp. 326-331 in *The Natural History of Sydney*, edited by D. Lunney, P. Hutchings and D. Hochuli. Royal Zoological Society of New South Wales, Mosman NSW. http://dx.doi.org/10.7882/FS.2010.027

McNab, B.K. 1963. Bioenergetics and the determination of home range size. *The American Naturalist* **97**: 133-140. http://dx.doi.org/10.1086/282264

New South Wales National Parks and Wildlife Service. 1998. *Lane Cove National Park: Plan of Management.* NSW NPWS, Hurstville NSW.

Newberry B. and Jones D.N. 2007. Presence of Asian house gecko *Hemidactylus frenatus* across an urban gradient in Brisbane: influence of habitat and potential for impact on native gecko species. Pp. 59-65 in *Pest or Guest: the Zoology of Overabundance*, edited by D. Lunney, P. Eby, P. Hutchings and S. Burgin. Royal Zoological Society of New South Wales, Mosman NSW. http://dx.doi.org/10.7882/FS.2007.009

North Sydney Council. 2003a. *Fauna Rehabilitation Plans: Primrose Park Bushland*. North Sydney Council.

North Sydney Council. 2003b. *Fauna Rehabilitation Plans: Tunks Park Bushland*. North Sydney Council.

Office of Environment and Heritage (OEH). *Atlas of NSW Wildlife* available at http://www.bionet.nsw.gov.au. Accessed 1 November 2012.

Pianka, E.R. and Pianka, H.D. 1976. Comparative ecology of twelve species of nocturnal lizards (Gekkonidae) in the Western Australian Desert. *Copeia* **1976**: 125-142. http://dx.doi.org/10.2307/1443783

Scanlon, J.D. and Davidson, C.L. 1999. Spring aggregation of the blindsnake *Ramphotyphlops nigrescens* (Typhylopidae). *Herpetofauna* **29**: 57-58.

Schlesinger, C.A. and Shine, R. 1994. Selection of diurnal retreat sites by the nocturnal gekkonid lizard *Oedura lesueurii. Herpetologica* **50**: 156-163.

Semeniuk, M., Ginn, S. and Muir, G. 2010. *Biodiversity Study of the Waverley Local Government Area*. Report prepared for Waverley Council. Australian Museum Business Services, Sydney.

Shea, G.M. 2010. The suburban terrestrial reptile fauna of Sydney – winners and losers. Pp. 154-197 in *The Natural History of Sydney*, edited by D. Lunney, P. Hutchings and D. Hochuli. Royal Zoological Society of New South Wales, Mosman NSW. http://dx.doi.org/10.7882/FS.2010.015

Smith, P. and Smith, J. 1992. *Flora and Fauna Study of McKay Reserve, Palm Beach.* Report prepared for Pittwater Municipal Council. P and J Smith Ecological Consultants, Blaxland NSW.

Stow, A. 1998. Diurnal retreat sites for Leaf-tailed geckos, *Phyllurus platurus*. *Herpetofauna* **28**: 25-29.

Swan, G. and Ehmann, H. 1996. Communal egglaying in the Broad-tailed gecko (*Phyllurus platurus*). *Herpetofauna* **26**: 35-36.

Swan, G., Shea, G. and Sadlier, R. 2004. *A Field Guide to Reptiles of New South Wales. 2nd Edition.* Reed New Holland, Sydney.

Threlfall, C.G., Law, B. and Banks, P.B. 2012. Influence of landscape structure and human modifications on insect biomass and bat foraging activity in an urban landscape. *PloS ONE* **7**: 1-10. http://dx.doi.org/10.1371/journal.pone.0038800

White, A.W. 2010. *Neverfail Bay and Oatley Point Reserve Fauna Study.* Report prepared for Kogarah City Council. Biosphere Environmental Consultants Pty Ltd, Rockdale NSW.

White, A.W. and Burgin, S. 2004. Current status and future prospects of reptiles and frogs in Sydney's urban-impacted bushland reserves. Pp. 109-123 in *Urban Wildlife: More than Meets the Eye*, edited by D. Lunney and S. Burgin. Royal Zoological Society of New South Wales, Mosman NSW.

Wilson, S.K. and Swan, G. 2013. *A Complete Guide to Reptiles of Australia. 4th Edition*. New Holland, Sydney.